INTEGRATED MICROWAVE BANDPASS AND BANDSTOP FILTER TO MULTIFUNCTION OPERATION IN WIRELESS COMMUNICATION SYSTEM

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DECLARATION

"I hereby declare that the work in this project is my own except for summaries and quotations which have been duly acknowledge."

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DEDICATION

Special dedication to my beloved parents,

Arham bin Wasimin & Hafizah binti Aris

To my backbone

Mohd Fadhil Jamaludin

Mohd Nazrul Nizam

Nazatul Asyikin

To my supervisor

PM. Dr. Zahriladha bin Zakaria

My friends and my fellow lecturers

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ABSTRACT

Ultra Wideband bandpass (UWB) filter provide a lot of advantage such as low power and high data precision. However, UWB bandpass filter easy to get the interference from the other radio frequency spectrum such as C-band satellite communication system 4GHz, radar system 10GHz, and X-band satellite communication 8.4GHz and radar system 10GHz. This project is to design the UWB bandpass filter integrated with Defected Microstrip Structure (DMS). Function of the DMS is to act as notched response. The pin diode added to act as tuning the notch response. The substrate used is Roger 4350B with thickness 0.508mm, dielectric constant 3.48 and loss tangent 0.0019. The tool for the measurement after the fabrication process is by using the Vector Network Analyser (VNA). The return loss must be better than 15 dB and the insertion loss around 0.1dB. When the pin diode on the notched response occur at 6.7GHz while when the pin diode off the notched response occur at 6.6GHz and 9.8GHz.

ABSTRAK

Ultra luas jalur penapis laluan jalur (UWB) penapis memberikan banyak kelebihan seperti tenaga yang rendah dan ketepatan data yang tinggi. Walau bagaimanapun, UWB penapis laluan jalur mudah untuk mendapat gangguan dari spektrum frekuensi radio yang lain seperti sistem komunikasi satelit C-band 4GHz, sistem radar 10GHz, dan X-band komunikasi satelit 8.4GHz dan sistem radar 10GHz. Projek ini adalah untuk mereka bentuk penapis UWB laluan jalur bersepadu dengan jalur tinggi bersepadu bersama dengan struktur mikro-strip (DMS). Fungsi DMS adalah untuk bertindak sebagai tindak balas bertakuk. Pin diod ditambah untukbertindak sebagai penalaan sambutan takuk. Substrat yang digunakan adalah Roger 4350B dengan ketebalan 0.508mm, pemalar dielektrik 3.48 dan kehilangan tangen 0.0019. Alat untuk mengukur selepas proses fabrikasi adalah dengan menggunakan *Vector Network Analyser* (VNA). Kehilangan pulangan mestilah lebih baik daripada 15 dB dan kehilangan sisipan sekitar 0.1dB. Apabila diod pin dibuka kepada sambutan bertakuk berlaku pada 6.7GHz manakala apabila diod pin ditutup sambutan bertakuk berlaku pada 6.6GHz dan 9.8GHz.

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UWB	**-**	**Ultra wide-band**
BPF	**-**	**Band-pass filter**
DMS	**-**	**Defected Microstrip Structure**
DGS	**-**	**Defected Ground Structure**
ADS	**-**	**Advance Design System**
RF	**-**	**Radio Frequency**
FCC	**-**	**Federal Communication Commission**
MMR	**-**	**Multimode Resonator**
WLAN	**-**	**Wireless Local Area Network**
DSLR	**-**	**Dual Stub Loaded Resonator**
VNA	**-**	**Vector Network Analyzer**
SIR	**-**	**Step Impeadance Resonator**

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CHAPTER I

INTRODUCTION

1.1 Introduction

The range of Ultra-wideband (UWB) is between 3.1 GHz to 10.6 GHz. This has been stated by the Federal Communication Commission (FCC) in 2002 for the commercial communication purpose [1]. Nowadays UWB technology plays an important role in short range and also high data rate in a wireless communication system. Since it has been released the UWB technology to get more attention in academic research and also an industrial researcher to gain more advantages from the UWB in a wireless communication system [2]. Ultra wideband bandpass filter consists a lot of advantages since it has been known such as high speed and high data short range communication system. Other than that, it also has the good material penetration capability, low power, low tools, cost and also in susceptibility to multipath [1-12]. UWB is also known because it's useful in localization or communication facility and also in sensor applications. There are a lot of numbers of researchers by using different methods and design methodology firm in UWB technology.

Unfortunately, the applicability of UWB band is limited because the interferences with the existing undesired narrow band radio signal [3]. An example of the radio signal that have been interferences with the UWB are WLAN at 5.8 GHz, satellite communication systems at 8GHz, RFID at 6.8 GHz and C-band satellite communication 4GHz. So the researchers concentrated on designing the UWB that can the interferences[4].

Most of the researcher design a lot of methods to remove the unwanted signal in UWB band.

1.2 Problem Statement

Ultra-Wideband (UWB) bandpass filter has the a lot of advantages such as low power consumption, good ratio of transmitting data, high speed data rate for many wireless applications [2]. There are a lot of applications have been used in UWB such as UWB radar systems for medical, military and so on [3]. Unfortunately, Wideband normally faces the interferences or interruption of other application signals such as C-band satellite communication (4GHz) and X-band applications like satellite communications (8.4GHz) and radar systems (10 GHz) cause the interferences with the UWB communication system. This will decrease the data accuracy, and also the data reception will decrease. As a solution, the Defected Micro-strip Structure, DMS is implemented to create a notch response to remove the unwanted frequency and prevent interferences that occur from other signals. Sometimes, the application that removes is needed, so the pin diode is used for tuning the notch response without any effect to the response.

1.3 Objectives

The objectives of this project are to design and develop wideband band-pass filter with tunable notch response. Design the DMS and implemented it in UWB to eliminate undesirable frequency with notch response. This project also needs to fabricate and validate the design of band-pass filter with tunable notch response through experimental works in a laboratory.

1.4 Scopes of Work

The purposes of this project is the design of Wideband Band-pass Filter with Tunable Notch Response of Wireless Communication System, the studies are based on UWB filtering with notch band, DMS technology and tunable function. The simulation part is carried out using Advanced Design System 2011 (ADS) software. The simulation process includes calculation, design, layout, simulation to obtain the frequency response and tuning process. The band-pass filter is designed by applying the method of short circuited stub. The wideband frequency is used from 3.1GHz to 10.6GHz as stated by the FCC in 2002. The insertion loss and return loss of this project is set to better than 0.5dB and 15Db respectively. The DMS is integrated in the design after the design of the band-pass filter to remove undesired frequency in a wireless communication system. The pin diode is added to act as a switch to tuning the notch response. All the band reject response must be better than 20 dB. The fabrication process is followed by the ADS software design and transfer into the Coral Drawing. After that, the band-pass filter integrated with DMS and Pin diode need to be measured by using a Vector Network Analyser. Finally, compare the simulation and measurement results.

1.5 Chapter Review

Chapter 1 describes a general overview of this project. This chapter demonstrates the introduction, problem statement, objectives, scope and review of all chapters of this dissertation.

Chapter 2 describes the finding of the project. The overall studies are related to Ultra wideband design and its application. This chapter describes the introductions of filter and defected microstrip structure. This chapter will explain the basic concept of the filter response. This chapter also will study and make comparison from the previous research that have done by the researcher.

Chapter 3 represented the methodology of the design process of tunable bandpass filter. The methodology involves the procedure of founding the design of filter, design UWB bandpass filter, DMS design and study the performance with tunable function.

Chapter 4 will present about simulation and measurement results. The results consist of the simulation result of transmission line, simulation result of micro-strip line, simulation result of microstrip line schematic with T junction and Via ground, simulation result of layout structure, performance various shapes of DMS, simulation result of filter when implemented DMS where pin diode off and pin diode on. Finally, the measurement result and comparison of simulation and measurement result are also shown in this chapter.

Chapter 5 will present the conclusion of this project after all the theoretical, simulated and measurement result is achieved. The future work also involved in this chapter to design the project in better performance.

CHAPTER II

LITERITURE REVIEW

This chapter will discuss about previous research that have been done by the previous researcher. Before starting the project, the literature review plays an important part. The overall studies are related to Ultra wideband bandpass filter design and its application. All the basic theory of design a bandpass filters cover in this chapter. There are a lot of method and technique to design a microwave filter. The further study about the DMS design. All the research and information that related to this project also explain in this chapter.

2.1 Ultra-Wideband (UWB)

The Federal Communication Commission (FCC) in 2002 has been specified the uses of ultra wideband with frequency band from 3.1GHz to 10.6GHz for commercial communication purpose [1]. This frequency also do not required license to use it. Ultra-wideband (UWB) is a radio technology that applies a huge frequency spectrum with a low energy level, power and high data rate for short-range communications [2]. UWB use base band pulses that without IF processing of ultra-short duration and spreads the signal energy across the bandwidth. UWB has very high data rates that transmission is about 1 to 2G-pulses per second. It consists of ultra high precision ringing that use the short pulse facilities. UWB is simplicity and low cost because it uses carrier-less radio impulses and without intermediate frequency. This will reduce the cost when compared with other communication systems. There are a lot of applications have been used this range of UWB such as in the military and also in medical application. In medical it has been widely used since it has the highest reception data rate. Example in the medical system is a wireless sensor network in the hospital.

2.1.1 UWB RF Systems and Application

The UWB consists of applications in several fields. The UWB radios send and receive with short pulses or cycles with high data rate. This is useful for high speed wireless local area network communications. Many applications in wireless technology are focused. Ultra-wideband system able to determine the distance between two objects based on the advantages of high precise time resolution. Ultra- Wideband has medicinal purposes that can propagate through the human body as well by detecting the human heart wall movements. Another application that can be applied is in the automobile field. Ultra-Wideband vehicular radars measure the location and movements of objects by transmitting and analyzing the reflected signals. This has been used in the military where they used as monitoring and tracking the enemies. Other than that, in the medical it had been widely used to replace the old technology. This is because UWB consists of high range data reception compared to the previous technology. Besides that previous technology need the doctor to be near to the patient. But by using UWB the doctor can monitor the patient outside room.

2.2 Introduction of Filter

In RF and microwave applications a filter is known has a two port network that controls the frequency response. It can provide transmission frequency within the pass-band and stop-band attenuation. The filter can be categorized into two which is a digital and analog filter. Digital filters are implemented using digital computer while the analog filter is divided into two parts which are active and passive. Analog filter is applied with R, L and C components. The rapid growth technology makes that a lot of researcher more attention to design RF and microwave filter to fulfil the requirement. The requirement can be determined in term of selectivity performances, size and lower cost. This is based on the needed by the industrial and also in the community. It can be designed by using different transmission line structures such as coaxial lines, micro-strip line and waveguide.

2.3 Type of filter

There are four types of filter which are low-pass filter, high-pass filter, bandpass filter and band-stop filter [14]. Low pass filter allows the low cutoff frequency to pass through, high-pass filter allow the high cutoff frequency to pass through, band-pass filter, select only the desired band of frequency, and bandstop filter eliminates the undesired band of frequency. The frequency responses include the characteristic of the filter. In addition, an ideal filter display zeroes insertion loss, constant group delay over the desired pass-band, and infinite rejection elsewhere. Figure 2.1 shows the example of the bandpass filter, bandstop filter, high pass filter and low pass filter.